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Vehicle Collision Reconstruction and Biomechanical Analysis

Robert Marberger v. Jeremy R. Nivens and DZYK Transportation Services, LLC

In the United States District Court for the
District of South Carolina, Columbia Division
C.A. No. 3:22-cv-02375-MGL

Date of Incident: September 9, 2021

Prepared for:

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S-E-A Matter No. 11.148372 DS

Issue Date: January 9, 2025

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION SEA Ltd. No. 909

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 26364 BRIAN M. BOGGESS

This item has been digitally signed and sealed by Brian M. Boggess, P.E., on 01/09/2025.

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Acronyms, Abbreviations and Definitions

'	foot/feet
"	inch/inches
%	percent
3D	three-dimensional
ACM	airbag control module
ASME	American Society of Mechanical Engineers
cm	centimeter
CT	computed tomography
ECM	electronic control manual
lbs.	pounds
mph	miles per hour
MVC	motor vehicle collision
NOAA	National Oceanic and Atmospheric Administration
QCLCD	Quality Controlled Local Climatological Data
SAE	Society of Automotive Engineers
VAR	vehicle accident reconstruction
VIN	vehicle identification number

I. Executive Summary

Matter Assignment

SEA, Ltd. (S-E-A) was requested to investigate an MVC that occurred on September 9, 2021, on Interstate 95 northbound (I-95 N) in Lynchburg, South Carolina. Three vehicles were involved: a 2000 Chevrolet K2500 (the Chevrolet), operated by Mr. Robert Marberger; a 2013 Peterbilt 386 (the Peterbilt), operated by Mr. Jeremy Nivens; and a 2020 International LT625 (the International), operated by Mr. James Miller and owned by Cowan Equipment Leasing. According to the Crash Report, all three vehicles were traveling northbound on I-95 N when the Chevrolet struck the rear of the International and the Peterbilt struck the rear of the Chevrolet and then struck the side of the trailer being towed by the International. S-E-A Discipline Lead Mechanical Engineering/VAR and Senior Biomechanics Engineer, Brian M. Boggess, P.E., conducted the investigation as S-E-A Matter No. 11.148372.

Scope

S-E-A was specifically requested to review the provided materials, perform research and analysis related to the MVC, and complete a reconstruction of the MVC, as well as a subsequent biomechanical analysis to determine the exposure and injury risk of a driver of the Chevrolet, such as Mr. Marberger, in the subject MVC.

Methodology

The methodology utilized by S-E-A during the investigation of this incident was in accordance with scientific methodologies and applicable principles. The investigation and analysis of any incident is a complex and scientific endeavor. The methodology of such an endeavor, therefore, must include the comprehensive, objective, and accurate compilation and analysis of the available data.

Conclusions

- **Mr. Marberger's testimony as to the sequence of events leading to the MVC is not supported by the physical evidence and an objective reconstruction thereof, nor are they even supported by the Plaintiff's own expert, Mr. Chapman.**
- **The energy associated with the frontal crush of the Chevrolet to the International significantly exceeded that evident within the sideswipe engagement(s) between the Peterbilt and the Chevrolet.**
- **Mr. Chapman's calculations report that the closing speed of the Chevrolet to the International was in the 18 to 20 mph range; however, due to his errors, this number is conservatively low.**
- **Mr. Chapman has not provided any calculations supporting that the contact between the Peterbilt and the Chevrolet transferred adequate momentum and/or energy to the Chevrolet to justify even his erroneously low closing speed of the Chevrolet to the International.**
- **The hypothesis that the Chevrolet struck the International first, followed by the Peterbilt's secondary contact, is feasible, and supported by the SCHP commentary of the incident video review, while Mr. Chapman's exclusion of such lacks a reliable application of the scientific methodology.**
- **Mr. Chapman's opinions as presented in his report and analysis are not based on sufficient facts or data, nor are his principles and methods verifiable.**
- **A frontal crash, such as the Chevrolet-to-International, provides both the mechanism and forces associated with the potential for significant injury.**

Signatures

S-E-A and the undersigned hereby certify the opinions and conclusions expressed herein were formed to a reasonable degree of professional certainty. They are based upon the application of reliable principles and scientific methodologies to all of the facts known by S-E-A and the undersigned when this report was issued, as well as knowledge, skill, experience, training, and/or education. Should additional information be discovered, S-E-A and the undersigned reserve the right to appropriately amend or augment these findings.

Prepared By:

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Technically Reviewed By:

Dusty A. Boyd/asj

Dusty A. Boyd

II. Procedures

1. **The following documents have been provided and reviewed:**
   - South Carolina Traffic Collision Reports:
     - 21273290
     - 21273291
   - Cowan Systems, LLC's (Cowan) Accident Report
   - Demand letter from Cowan
   - Cowan's repair invoices
   - Photographs of the scene and vehicles
   - Dash camera footage from the South Carolina Department of Public Safety Highway Patrol (SCDPS)
   - Dash camera footage from the Sumter County Sheriff's Department
   - Report of Southeast Forensic Consultants, dated October 21, 2024
   - File produced by Southeast Forensic Consultants
   - Preliminary Life Care Plan Report of Southeastern Life Care Planning, dated October 21, 2024
   - Deposition transcript of Mr. Marberger, taken November 30, 2022
   - Deposition transcript of Mr. Nivens, taken November 8, 2024
   - Plaintiff's Amended Expert Witness Disclosure
   - Medical records of Mr. Marberger
2. **The following documents/data were obtained and reviewed:**
   - Vehicle specifications and testing results/requirements for the subject vehicles, including those obtained from the following sources:
     - VinLink™
     - Diesel Truck Index
     - CarFax
     - ClearVIN™
     - Expert AutoStats®
     - Motor® Crash Estimating Guides
     - NHTSA Crash tests (e.g., v3019)

- Satellite imagery of the MVC site via maps on Google Earth™ and Bing®
- NOAA QCLCD weather data for September 2021

3. **Peer-reviewed and published literature was reviewed in support of the subject analysis. Examples of this literature include, but are not limited to:**
   - Cheng, P., Tanner, C. B., Chen, H., Durisek, N., & Guenther, D. (2005). *Delta-V, Barrier Equivalent Velocity and Acceleration Pulse of a Vehicle During an Impact* (Technical Paper No. 2005-01-1187). SAE. https://doi.org/10.4271/2005-01-1187.
   - Fricke, L.B. (1990). *Traffic Accident Reconstruction*, The Traffic Accident Investigation Manual, Volume 2. Evanston: Northwestern University Traffic Institute.
   - Fricke, L.B. (2010). *Traffic Accident Reconstruction*, The Traffic Accident Investigation Manual, Volume 2. Evanston: Northwestern University Traffic Institute.
   - Wiechel, JF, Morr, DR, & Boggess, BM. (2010). Application of the Scientific Method to the Analyses in Forensic Science With Case Example. *Proceedings of the ASME 2010 International Mechanical Engineering Congress and Exposition. Volume 11: New Developments in Simulation Methods and Software for Engineering Applications; Safety Engineering, Risk Analysis and Reliability Methods; Transportation Systems,* (Paper No. 2010-39044), pp. 515-522. ASME. https://doi.org/10.1115/IMECE2010-39044
4. **S-E-A inspected the Chevrolet on December 18, 2024. Photographs, notes, and measurements, including 3D laser scans, were captured at that time.**
5. **A reconstruction of the MVC was performed utilizing accepted peer-reviewed, published engineering and reconstruction methodologies.**
6. **A biomechanical analysis for the exposure of a driver within the Chevrolet was performed utilizing accepted peer-reviewed, published engineering and scientific methodologies.**

III. Discussion

Collision Scenario

The subject MVC reportedly occurred on September 9, 2021, at approximately 11:20 a.m. on I-95 N in Lynchburg, South Carolina. According to the Crash Report, the Chevrolet, operated by Mr. Marberger, contacted the rear of the International, operated by Mr. Miller. The Peterbilt, operated by Mr. Nivens, then struck the rear of the Chevrolet before striking the side of the International's trailer in tow. The Crash Report, as it relates to restraint/safety device usage, notes "None Used" for the Chevrolet's driver, Mr. Marberger. Mr. Marberger has claimed to have sustained injuries as a result of the MVC.

Background

Crash Report

South Carolina Department of Public Services (DPS) issued two separate Crash Reports in this matter. Post-MVC dash camera video, with audio, was provided for review. The investigating officer can be heard describing two crashes, as well as having reviewed a video of the MVCs, with his intent to issue two separate reports accordingly. The audio describes that traffic had slowed, including the Chevrolet in the rightmost lane, and that the Peterbilt moved to the right shoulder but sideswiped the Chevrolet. He then describes that the Peterbilt slowed and reentered the right lane behind the Chevrolet, before the Chevrolet then later crashed into the rear of the International, followed by the Peterbilt contacting the Chevrolet again, in its rear.

According to Crash Report 21273290:

> *"Units 1 [Peterbilt] and 2 [Chevrolet] were traveling north on Interstate 95. Unit 1 [Peterbilt], who was driving too fast for conditions, sideswiped Unit 2 [Chevrolet]." The Crash Report diagram depicts the Chevrolet in the rightmost lane of I-95, whereupon the Peterbilt moved to the right shoulder and sideswiped the Chevrolet (***Figure 1***).*

According to Crash Report 21273291:

> *"Unit 1 [Chevrolet], who was driving too fast for conditions, struck the rear of Unit 3 [International]. Unit 2 [Peterbilt], who was also driving too fast for conditions, struck the rear of Unit 1 [Chevrolet] before striking the side of Unit 3's [International's] trailer." The Crash Report diagram depicts all 3 vehicles in the rightmost lane of I-95, with the Chevrolet crashing into the rear of the International, followed by the Peterbilt moving to the right shoulder again, and making contact to the other vehicles (***Figure 2***).*

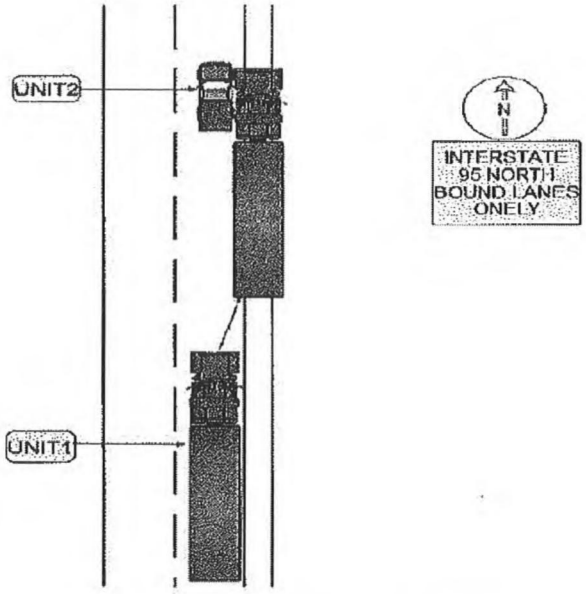

Figure 1: Crash Report 21273290 diagram.

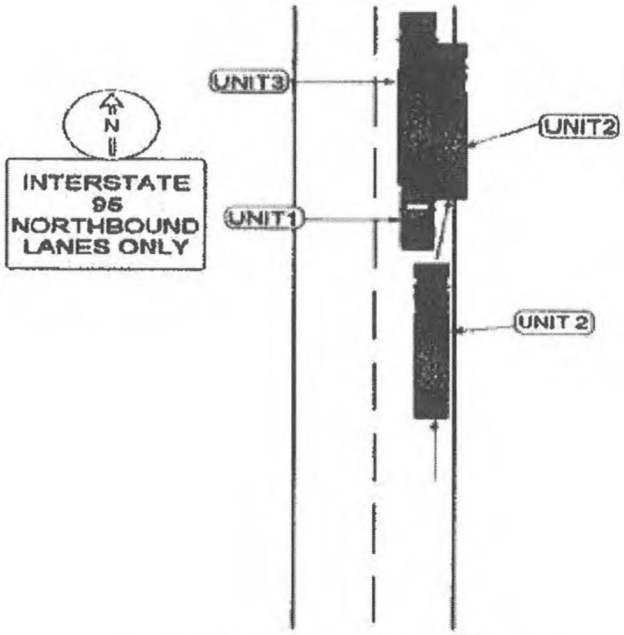

Figure 2: Crash Report 21273291 diagram.

Statements

Mr. James Miller

Mr. Miller completed an incident report regarding the MVC. It is noted that the MVC occurred September 9, 2021, on I-95 N, near mile marker 143. According to the report:

> *"Tractor Trailer aprox. 1/8 mile in front of me appeared to be stopped on the road. Traffic slowing rapidly. Pushed on 4 way button as I applied brakes. Pickup following me slammed into me. Tractor Trailer following him ran off highway to the right. Scrapped [sic] front bumper on my R side trailer tires then jackknifed."*

Depositions

Mr. Robert Marberger

Mr. Marberger was deposed in the subject matter on November 30, 2022. Mr. Marberger testified that on the day of the subject MVC, he was on his way from Florida to his home in Pennsylvania. He reportedly had been driving seven to eight hours prior to the MVC. He stated that he was driving a Chevrolet 2500 flatbed extended cab, for which he checked the functionality of the brake lights prior to leaving Florida. He also stated that there was red and white reflective tape on the sides and rear of the flatbed at that time.

Mr. Marberger testified that at the time of the MVC, he was traveling in the "far left lane" when "the truck came in my lane, hit me in the side, and smacked me in the wall" before being "knocked out." He testified that when he "woke up" his Chevrolet was "in the middle of the street" between two tractor-trailers. He stated that he was lying on his back across the front seats and console of the Chevrolet looking out the passenger window. Mr. Marberger stated that the tractor-trailer at rest in front of his Chevrolet was the tractor-trailer that previously hit him from the side. Mr. Marberger testified that post-MVC, he was immediately taken away by an ambulance because he was "bleeding really bad." Prior to the subject MVC, he claimed that he had a free and clear passage ahead of him in the lefthand lane and was traveling the speed limit of 70 mph, unbelted. He denied being distracted by his cell phone and claimed he was not taking any prescription medications at the time of the subject MVC. He testified that he does not remember rear-ending any other vehicle at any point and that he does not accept any responsibility for the subject MVC.

Mr. Marberger is claiming brain damage, a lacerated left eye, thirteen bone fractures, and post-collision soreness in his back, hips, and knees, as a result of the subject MVC. Regarding the brain damage, Mr. Marberger testified that he had a subdural hematoma behind his left eye causing lingering forgetfulness, memory loss, and imbalance, for which he is still being treated. He testified that his fractured bones were part of his forehead, nose, sternum, and ribs. He claimed that the airbag did not deploy and that it is possible these injuries resulted from contact with the steering wheel. Mr. Marberger testified that post-MVC medical conditions unrelated to the MVC include primary myelofibrosis and myeloproliferative pneumosis, for which he is also still undergoing treatment.

Mr. Jeremy Nivens

Mr. Nivens was deposed in the subject matter on November 8, 2024. He testified that he attended TransTech Charlotte Diesel Driving Academy in 2006 to 2007. He stated that he was employed by Dzyk Transportation Services and had a current medical certificate at the time of the MVC.

Regarding the subject MVC, Mr. Nivens testified that the roadway was wet and that he was operating the 2013 Peterbilt 386 at the time of the MVC. He stated he was pulling an empty trailer, traveling in the righthand lane behind Mr. Marberger (Chevrolet) who was behind the International. He testified that the International "threw on brakes to stop," and Mr. Marberger hit the International in the back. He described that impact as Mr. Marberger "rocked it. It was real hard." Mr. Nivens testified that after the "tail end" of Mr. Marberger's truck came "up in the air" and slammed "back down," he "applied the brakes on wet pavement real quick." Mr. Nivens testified that this caused his tires to go "to a skid." He stated that "instead of me going in the back of him [Mr. Marberger], I counter steered around, and when I went around him, the tail end of my tractor . . . brushed up against the flatbed" of Mr. Marberger's Chevrolet. Mr. Nivens testified that his Peterbilt came to rest on "the shoulder of I-95" as a result. Mr. Nivens claimed that there was damage from his left-front fender to the left side of the sleeper berth. Mr. Nivens also testified that there is no wall along the section of I-95 where the subject collision occurred.

Plaintiff's Expert - Mr. Carter Chapman

Mr. Chapman, on behalf of the Plaintiff, authored a report in this matter in the area of accident reconstruction. In the outset of his report, Mr. Chapman's "description of the accident," in contrast to the Crash Report, was as follows:

> *"V1, V2, and V3 were all traveling northbound on interstate 95. The green 2020 International tractor trailer (V3), driven by James Miller, was in front of the gold 2000 Chevrolet 2500 (V1) driven by Robert Marberger, and the white 2013 Peterbilt tractor trailer (V2), driven by Jeremy Nivens was in the rear. The white Peterbilt (V2) swerved in an attempt to avoid striking the gold Chevrolet (V1) and green International (V3) who were braking in front of him. The white Peterbilt (V2) subsequently impacted the rear of the gold Chevrolet (V1) who then impacted the rear of the green International (V3)."*

Mr. Chapman's report lists several forms of physics analyses (e.g., crush analysis, momentum analysis) that he purportedly utilized in his analysis, and some drawings and equations were ultimately provided with Mr. Chapman's file production. Ultimately, Mr. Chapman opined, among other items, that:

- The Chevrolet had only one impact with the rear of the International.
- The International was near stopped at the time the white Peterbilt rear-ended the gold truck.
- The Peterbilt was traveling approximately 30 mph at the time it rear-ended the Chevrolet, which propelled the gold Chevrolet into the rear of the green International.
- The Chevrolet would have a forward directed change in velocity (DV) from getting rear-ended by the Peterbilt, followed by opposite directed DV from hitting the back of the International.
- The closing speed of the Chevrolet into the International was between 15 and 20 mph, causing the Chevrolet to have a near 15 mph DV.
- If the Peterbilt had maintained a safe following distance and been attentive, there would have been ample time to stop before colliding with the gold Chevrolet.

A study of Mr. Chapman's analysis and opinions will be made below in the Analysis section of this report.

Site/Vehicles

Site

In the area of the subject MVC, I-95 generally runs northeast/southwest, with two lanes of northbound travel, a wide paved shoulder to the right and narrow paved shoulder to the left (**Figure 3** and **Figure 4**). The median is tree lined, and there is no evident guardrail or wall on either side of the roadway. According to the Crash Report, the conditions at the time were dry, clear, and daylight, with the roadway reported as straight and level.

Figure 3: Aerial image of the MVC site (from Google Earth).

Figure 4: Street-level image near the MVC site, looking northbound (from Google Earth).

Vehicles

Chevrolet

The subject Chevrolet bears VIN 1GCGK29JXYF515967, indicating that it is a 2000 model Chevrolet K2500. Published specifications report a curb weight of 5,290 lbs., a static front bumper height, as measured to its top surface, of 26". A CarFax report for the Chevrolet lists the subject MVC, dated September 9, 2021, as a sideswipe collision with damage to the front and right side of the Chevrolet. Copies of post-MVC photographs were provided for review and evaluation (**Figure 5** and **Figure 6**). These photographs depict contact damage to the front/left front, right side, and right rear of the Chevrolet.

The Chevrolet was inspected by S-E-A on December 18, 2024, in Hudson, Florida. Initial investigation of the Chevrolet found a few noticeable differences in the vehicle since the time of the MVC, but overall, much of the vehicle at least appeared similar to the post-MVC photographs. At the front of the vehicle, the grill was no longer in place (**Figure 7**), while at the rear, the hitch ball and mount had been removed, as well as some of the rear lighting (**Figure 8**).

As part of the inspection, the vehicle was documented with field notes, photographs, and measurements, including the usage of 3D laser scanning. The date of manufacture was noted as June 2000 and the current odometer reading was 211,492 miles. The instrument cluster gages were returned to zero (e.g., speedometer and tachometer), as inspected. The driver seat belt was found to be statically functional, and the webbing and guides did not exhibit any evidence of burnish.

The front structures of the Chevrolet are notably crushed (longitudinally rearward), with a vertical narrow object impression to the front bumper structure at or near its midline. The hood is folded upward, seemingly hinged at the crush bead within its frame. The left side fender and structures are more displaced than the right, consistent with an offset/angular hit (**Figure 9** and **Figure 10**).

Separate from the frontal damage, the flat bed remained secure to the frame of the Chevrolet and maintains its general structural profile, albeit somewhat out-of-plane (**Figure 11**). The right-rear tire is flat, but the wheel is structurally intact without evidence of significant loading. The

forward area of the right leaf spring is bent, but the overall structure appears intact. Additionally, a generally horizontal and vertically narrow crease within the right-side door panels is evident (**Figure 12**). There is lateral displacement of the exterior right-side door panels, but no evidence of significant longitudinal gouging and scraping.

Figure 5: Chevrolet, front view at the Site (provided photograph).

Figure 6: Chevrolet, right-rear corner view at the Site (provided photograph).

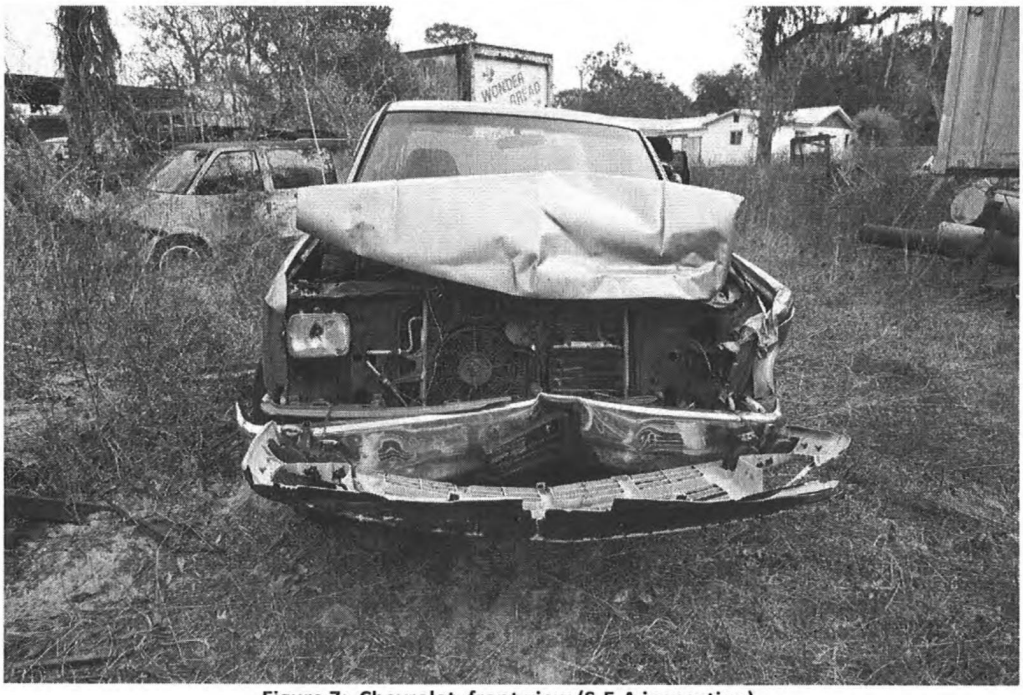

Figure 7: Chevrolet, front view (S-E-A inspection).

Figure 8: Chevrolet, right-rear corner view (S-E-A inspection).

Figure 9: Chevrolet, left side view (S-E-A inspection).

Figure 10: Chevrolet, right-front view (S-E-A inspection).

Figure 11: Right rear wheel and suspension of Chevrolet (S-E-A inspection).

Figure 12: Right door of Chevrolet (S-E-A inspection).

International

The subject International bears VIN 3HSDZTZRXLN102113, indicating that it is a 2020 International LT625, with an L6, 12.4L diesel engine. As depicted in the Crash Report, the International was towing a semi-trailer at the time of the MVC. Post-MVC photographs were provided and depict MVC damage to the International (**Figure 13**). These photographs depict contact damage at the rear of the trailer at the ICC bar. ECM data from the International was not provided/available for review and analysis.

Figure 13: International semi-trailer, rear view at the Site (provided photograph).

Peterbilt

The subject Peterbilt bears VIN 1XPHDP9XXDD194694, indicating that it is a 2013 Peterbilt 386, with an L6, 12.9L Paccar engine. As depicted in the Crash Report, the Peterbilt was towing a semi-trailer at the time of the MVC. Post-MVC photographs were provided and depict MVC damage to the Peterbilt (**Figure 14**). These photographs depict slight contact damage to the fiberglass hood and fender structure adjacent to the left headlight, deflection of the lower driver entry step, scuffing and denting of the saddle tank, as well as a singular gouge to the sleeper berth body shell. ECM data from the Peterbilt was not provided and/or was not available for review and analysis.

Figure 14: Peterbilt, left side view at the Site (provided photograph).

Analysis

Reconstruction

A review and analysis of the provided and available data was performed to attempt to reconstruct the evidence in this matter. As seen in Figure 6, the Chevrolet came to rest in the rightmost lane of I-95 N, near the right edge. The International (Cowan) vehicle is stopped ahead on the right shoulder, estimated at approximately 200 to 300 feet ahead. The Peterbilt is angled counterclockwise to the travel direction and is on the right shoulder, split between pavement and grass shoulder (see Figure 14). Excerpted from the provided SCDPS video, **Figure 15** depicts the trailer in-tow by the Peterbilt at final rest, along with tire marks of the trailer as it departed the roadway.

Figure 15: Trailer in-tow by Peterbilt, post-MVC (provided photograph).

The Chevrolet sustained multiple contacts, including a frontal event whereby its front struck the rear of the leading International. Such contact led to crush along the front structures of the

Chevrolet. Utilizing the crush profile, the barrier equivalent velocity (BEV) of the Chevrolet related to the frontal event was in the range of approximately 15 mph. BEV is a physical term in reconstruction whereby its intent is to "quantify the energy required to cause the damage associated with an impact" defined as "...the speed with which the vehicle would have to strike a rigid barrier in order for it to absorb the same amount of crush energy as it did in the actual impact" (SAE 2005-01-1187). This is not to say the Chevrolet's relative impact speed was the BEV, nor is this the change in velocity of the Chevrolet (delta-V), which can be defined as "the change in the vehicle velocity vector from just before the impact until just after the impact." Both the impact speed and change in velocity of the Chevrolet are necessarily greater than the frontal BEV reported as the BEV is only representative of the energy associated with the crush damage to the vehicle, as opposed to the net change in overall kinetic energy or other energy dissipation and/or transfer.

In addition to the frontal impact, the Chevrolet exhibited contact along its right side. The crush along the right-side doors was vertically narrow and did not significantly involve the primary structures such as the side sill or A- and C-pillars. Utilizing this crush profile, the BEV of the Chevrolet related to the side crush of the door panels was in the range of only 5 to 6 mph. In addition, side swiping of the flat bed, as well as deflection of the leaf spring occurred but does not seemingly account for the input of sufficient energy to account for the frontal crash of the Chevrolet to the International. For the reasonably quantifiable damage, **the energy associated with the frontal crush of the Chevrolet to the International significantly exceeded that evident within the sideswipe engagement(s) between the Peterbilt and the Chevrolet**.

The analysis of and reporting on the subject MVC has had multiple hypotheses formulated related to the cause(s) thereof. These include, but are not necessarily limited to:

Mr. Marberger was traveling in the left lane of I-95 N when the International merged left into the left lane and struck the Chevrolet, precipitating the events (from Marberger deposition).

There are multiple crashes whereby the Chevrolet, in the rightmost lane, was first sideswiped by the Peterbilt from the right shoulder. The Peterbilt then slowed and re-entered the right lane, the Chevrolet struck the rear of the International, and then the Peterbilt struck the Chevrolet again in its rear (SCDPS).

The Chevrolet struck the rear of the International, followed by the Peterbilt making secondary contact to the Chevrolet and the International (Nivens testimony and Miller statement).

The Peterbilt struck the rear of the Chevrolet, followed by the Chevrolet striking the International (Chapman report).

For the first of these hypotheses, Mr. Marberger testified that he was traveling in the left lane of I-95 N, when the Peterbilt entered the left lane, struck the Chevrolet in the side, and forced him into a "wall." Based on an objective analysis, there is no evidence to place Mr. Marberger and his Chevrolet in the left lane of I-95 N, nor that the Peterbilt entered the left lane and struck the Chevrolet therein. An examination of the area of the MVC finds no "wall" from which the Chevrolet could come into contact, nor any evidence on the left side of the Chevrolet to substantiate such contact occurred. Overall, **Mr. Marberger's testimony as to the sequence of events leading to the MVC is not supported by the physical evidence and an objective reconstruction thereof, nor are they even supported by the Plaintiff's own expert, Mr. Chapman.** Thus, this hypothesis can be reliably eliminated.

The latter three hypotheses require objective data and analysis to establish speeds, positions, and forces by which to exclude and/or substantiate. Mr. Chapman authored a report in this matter offering the fourth hypothesis as his fundamental opinion with little or no basis on the sequence of events nor his actual verifiable methodology in arriving at such. The evidence in this case is limited, and thus, an objective reconstruction is similarly limited. Regarding the scene, there was little to no scene documentation of skid marks, final rest, or other similar evidence. As far as witnesses, this author is unaware of any independent witnesses to-date, and Mr. Marberger's recount has been shown to be inconsistent with the physical evidence that is available. To-date, no video of the MVC(s) have been provided or located for independent review and analysis either; however, the investigating officer's findings were reportedly based on his review of a provided video. The only vehicle that was available for inspection was the Chevrolet, and it lacks any objective electronic data (e.g., ACM) for analysis. Neither the International nor the Peterbilt had inspections completed and no electronic data was preserved (e.g., ECM or telematics).

Mr. Chapman's analysis was studied for consistency and accuracy with accident reconstruction methodologies. His layouts are generally limited to explaining a couple of the contact points but do not provide a basis for the initial speeds nor sequence of events. His calculations are generally summarized into two areas: (1) collision analysis of the Chevrolet to the International, and (2) braking analysis of the Peterbilt. These will be addressed separately.

Regarding Mr. Chapman's Chevrolet-to-International collision analysis, he begins by doing a crush analysis on the bumper and hood of the Chevrolet to calculate a BEV utilizing a couple different assumptions for the vehicle stiffness. He then utilized force-balance methodologies to attempt to quantify the energy absorbed by the International. In this analysis, Mr. Chapman assumes the A and B stiffness coefficients of the International's trailer as 1000 lbf/in and 1000 lbf/in^2, respectively. Citing to Fricke (1990), "certain limitations exist in" crush energy models, "the most obvious limitation exists with the crush stiffness coefficients." These stiffnesses are typically derived from barrier tests, which no such test was utilized or referenced by Mr. Chapman. Other limitations exist with crush energy models such as being limited to a uniformity assumption across the width of damage, ignores localized effects of frames, and does not allow for vertical variances in crush, etc. Further, Fricke (1990 and 2010) provides a case example whereby the author compared/contrasted conservation of momentum versus conservation of energy analyses. When utilizing conservation of energy only in the collinear example provided, Fricke wrote, "the total kinetic energy before the impact clearly is not equal to the total kinetic energy after the impact...because some of the energy was dissipated in subtle ways" and as "not all the forms of energy...were accounted for." The subject case example published by Fricke found a 100% error rate in the energy-only analysis. While Mr. Chapman's notes and report list that he applied "conservation of momentum and conservation of energy," the actual formula he utilized, according to Fricke (2010) and as derived, is "based on the energy calculations" in arriving at his ultimate closing speed and change in velocity calculations. From his flawed methodologies, **Mr. Chapman's calculations report that the closing speed of the Chevrolet to the International was in the 18 to 20 mph range; however, due to his errors, this number is conservatively low**.

Mr. Chapman's additional calculations are entitled "Speed at Impact - Peterbilt," wherein he seemingly is attempting to conduct a braking analysis of the Peterbilt. He lists "distance traveled

from impact to rest as 45 to 70 feet and then applies a drag factor of 0.45 to 0.60 g to the Peterbilt to calculate a pre-braking speed of the Peterbilt. Mr. Chapman's work to establish these distances is not reported, and he lacks a basis to establish the magnitude of the braking drag factor. The trailer does exhibit some drag marks, but the actual braking by the power unit is unknown. Further, even if his purported speed range was accurate, such knowledge still does not allow for him to conclude that the Peterbilt's contact to the Chevrolet preceded the Chevrolet-to-International collision. The contact between the Peterbilt and Chevrolet was not collinear, and therefore, no common velocity assumption can be made. Instead, the subject collision is more consistent with a sideswipe/snag interaction, whereby the Chevrolet and Peterbilt did not reasonably reach a common velocity. Thus, calculations as to the Peterbilt speed are not particularly relevant to the collision dynamics. Overall, **Mr. Chapman has not provided any calculations supporting that the contact between the Peterbilt and the Chevrolet transferred adequate momentum and/or energy to the Chevrolet to justify even his erroneously low closing speed of the Chevrolet to the International.**

Overall, **the hypothesis that the Chevrolet struck the International first, followed by the Peterbilt's secondary contact, is feasible, and supported by the SCHP commentary of the incident video review, while Mr. Chapman's exclusion of such lacks a reliable application of the scientific methodology. Mr. Chapman's opinions as presented in his report and analysis are not based on sufficient facts or data, nor are his principles and methods verifiable.**

Biomechanics

Definition

Biomechanics is the science of applying mechanics-based engineering principles to a living body. A human is an example of such a living body or biological system. Humans are composed of various structural elements, each of which possesses certain quantifiable physical and material properties. Mechanics, by definition, is the branch of physics concerned with the analysis of the action of forces on bodies and objects, including, but not limited to, movement and structural effects. A mechanical engineer, therefore, studies and analyzes machine-based systems in terms of structure, function, and the application/implications of forces. Correspondingly, a biomechanical engineer analyzes living bodies as the mechanical system that they are in terms

of their structure, functionality, force transmission, and force implications. The scientific basis of mechanics, and therefore biomechanics, comes from the application of Newton's three laws of motion. Regardless of the object, material alteration and/or failure are dependent upon the stress and strain imparted. Stress and strain are directly related to the forces and/or moments present within a particular structure. In terms of a living body, the material alteration and/or failure is referred to as injury to the subject body region (e.g., bone fracture or muscle strain). Biomechanics is distinct from the practice of medicine in that biomechanical engineers address injury causation due to mechanical forces and the resulting mechanisms of injury, whereas the diagnostic and prognostic process, applied with the field of medicine, attempts to determine the most likely source of a symptom (or set of symptoms) and treat those symptoms, without the need to consider or evaluate the cause of the injury or condition.

Through kinetics, the motion (or kinematics) of a body is characterized as a function of the forces present, or potentially present, for a given set of boundary conditions. From a biomechanical perspective, injury is defined as damage sustained by tissues of the body caused by physical trauma. In order to cause a specific injury to the human body during a single event, that event must provide a proper mechanism, as well as induce stresses within the body region of sufficient magnitude to alter, or fail, the subject tissue. Mechanism refers to the manner or direction in which the loading is applied (e.g., extension) and further the extent to which the system moves in reaction to the loading (e.g., joint motion). Similar to all materials, the mechanism of loading dictates how a material will react to the stress imparted and the mode in which it may fail. The material limits or injury threshold dictate the sustainable stress limits. From a global perspective, an injury is necessarily the composite of both a proper mechanism and sufficient stress magnitude.

A recognized scientific method for analyzing a material failure (e.g., injury) is to compare the loading present in a given event to that of specific testing involving similar materials with known failure mechanisms and stresses. Within biomechanics, this would include evaluative testing of humans and/or human surrogates. Ultimately, if a given event does not provide both the mechanism and stress necessary for a given injury, then the injury causation would not reasonably be correlated with having resulted from such an event.

When analyzing human exposure to accelerations, the standard method of reporting these accelerations is to put them in terms of a "g." One g is equal to the acceleration due to the earth's gravity and is always acting in a downward direction on every object on the earth. As a fundamental example of its use, applying Newton's laws of motion, the weight of an object on earth is a force, is equal to its mass times 1 g, and is realized by the effort required to keep that object from moving toward the earth.

Medical Claims/Reports

According to the provided medical records, Mr. Marberger was born on September 24, 1963, making him 57 years old at the time of the subject MVC. His height and weight, at or near the time of the MVC, were reported as approximately 6'0" and 167 lbs., respectively. Initial records indicate Mr. Marberger was an unrestrained driver involved in an MVC. Initial nursing notes wrote that he had a large subconjunctival hemorrhage, positive hyphema, 2 cm laceration through upper lid/tarsal plate and lid margin, visual acuity intact, significant contusions on his face, left forehead, left knee, and right tibia, positive midline cervical tenderness to palpation, and a soft, large mass noted in left upper quadrant of the gastrointestinal region. His initial diagnosed injuries included:

- Head/Cervical Spine (CT)
  - Subdural hematoma seen along the falx and anterior frontal region measuring up to 9 to 10 mm in thickness along the falx.
  - Large amount of soft tissue swelling and large left frontal scalp hematoma.
  - Slightly angulated neck left nasal bone fracture and fracture through the septum.
  - Marked soft tissue swelling at the pre-septal and periorbital soft tissues on the left and overlying the acute nasal bone fracture.
  - Moderate to severe intervertebral disc space narrowing at C5-6 posteriorly with some minor spurring and endplate changes.
- Chest/Abdomen (CT)
  - Comminuted fracture of the T1 vertebral body with paraspinal hematoma seen anteriorly.
- Left Knee (X-ray)

- Thin curvilinear lucency at lateral patella greater inferiorly. No typical pattern for bipartite patella and would recommend correlation with point tenderness as this is suspected to reflect an acute fracture.

The kinematics and kinetics of an unrestrained occupant in a significant frontal impact have repeatedly been documented within the accident reconstruction and biomechanical literature. The subject Chevrolet was not equipped with a frontal airbag, which further exposes a driver to increased risk of injuries due to the concentrated impact loading of a driver into forward structures (e.g., steering wheel). **A frontal crash, such as the Chevrolet-to-International, provides both the mechanism and forces associated with the potential for significant injury.**

Appendices

Investigator Credentials

1. Investigator CV
2. Investigator Testimony Log
3. Investigator Billable Rate Disclosure